Chapter 4. History of Conservation and Management Measures

4.1 Regulatory History

The regulatory history of the commercial market squid fishery began with a ban on squid attracting lights in 1959. The addition of section 8397 to the Fish and Game Code prohibited the use of these lights in the Monterey Bay fishery. Processors believed that squid caught with the aid of attracting lights were of poorer quality and smaller in size than those caught without lights. The fishermen also felt that the lights disrupted the spawning. Further, banning attracting lights would prevent canneries from harvesting squid directly from their docks. This regulation was lifted in 1987 for most of Monterey Bay (District 17); in 1988, attracting lights were once again allowed in Pacific Grove area in Monterey Bay (District 16).

In 1983, the Commission introduced regulations that limited the days of the week and times of day that fishermen could engage in the take of market squid. Section 149, Title 14, California Code of Regulations (Title 14) prohibited any vessel, using or possessing a roundhaul net in Monterey, from taking market squid between noon on Friday and midnight on Sunday, and between noon and midnight on any day Monday through Thursday. Senate Bill (SB) 1080 (Mello) was chaptered in 1989; it allowed fishermen to utilize all types of roundhaul nets, including purse and half-purse seine nets, in the take of market squid in the Pacific Grove area (District 16). One year later, the Commission amended Title 14 to allow for the take of squid by roundhaul gear before midnight Monday through Thursday north of a line running 252º magnetic from the Moss Landing Harbor entrance.

In 1993, the market squid landing tax was increased to $0.0019 per pound (SB 1030 Thompson). The same year, Assembly Bill (AB) 14 (Hauser) restricted vessels from the use of squid attracting lights in District 10 (north of Monterey Bay to the southern boundary of Mendocino County).

Prior to April 1998, the market squid fishery was largely an unregulated, open access fishery. As a result of increasing market interest and rising squid landings, Senate Bill 364 (Sher), was passed in 1997. This legislation established a $2,500 permit for market squid vessels and light boats and a three-year moratorium on entry into the fishery; called for a three-year study of the fishery; and provided for the creation of a Squid Fishery Advisory Committee and a Squid Research Scientific Committee to advise the California Department

of Fish and Game (CDFG) on research and interim measures. Interim measures adopted included logbooks, extension of the weekend closure to southern California, and shielding requirements and wattage limits for squid-attracting lights (§149, Title 14, CCR 2000). Senate Bill 364 also required that the Department present a report on the fishery to the Legislature, with recommendations for a conservation and management plan by April 2001.

In 1998, the Marine Life Management Act (MLMA), also known as the Keeley Bill (AB 1241), was passed and became law. In 1999, the state provided $5.2 million to fund this legislation. The MLMA requires that the State of California take several actions, including:

- Transference of many fishery management authorities from the state legislature to the California Fish and Game Commission (CFGC).
- Development of a master plan for implementing the MLMA.
- Development of management plans for California state fisheries. .
- Development of a plan for dealing with emerging fisheries as they become operational in California.

Senate Bill 1544 (Sher) became law in 2000. This bill reduced the market squid permit fee to $400 from $2,500 until April 2003 and extended the sunset date for SB364 to 1 January 2004. When Governor Davis signed this legislation, he did so to ensure uninterrupted protection and regulations for the squid fishery, but requested that the Legislature, squid fishermen and their representatives as well as other stakeholders “review the appropriateness of the squid permit fee.”

Senate Bill 209 (Sher) was passed in 2001. This legislation delegated the authority to manage the state's ecologically important and commercially valuable squid fishery to the California Fish and Game Commission and requires that the Commission adopt a market squid fishery management plan by 31 December 2002. Other features of this bill included providing that specified provisions will become inoperative upon the adoption by the commission of a market squid fishery management plan and the adoption of implementing regulations and will be repealed 6 months thereafter.

The Commission adopted interim measures for the market squid fishery under Title 14, §149. In 2000, the Commission prohibited the commercial take of market squid between noon on Friday and noon on Sunday from Pt. Conception south to the US-Mexico border and required commercial squid vessels and light boats to maintain logbooks detailing fishing/lighting activities. In response to potential negative effects of vessels lighting for squid and nesting seabirds on several of the Channel Islands, the Commission adopted regulations restricting attracting lights to a maximum of 30,000 watts and required that lights be shielded. In 2001, the Commission established a harvest guideline of 125,000 short tons for the market squid fishery. The harvest guideline selected was based on the highest seasonal catch level for the fishery and would serve to

prevent volumetric growth of the fishery should market demand encourage such expansion.

Table 4.1 Summary of Market Squid Regulations from 1959 to the present.

Date	Bill # (Author)	Regulation(s)
1959	§8397	It is unlawful to use any artificial light to lure or attract squid in Districts 16 and 17. This section applies to all artificial lights except those lights necessary for the usual operation of a vessel not used to lure or attract, or intended to lure or attract, squid.
1983	AB 513 (Farr)	Authorizes the Commission to adopt regulations specifying the days of the week and times of the day when squid may be taken north of Point Conception.
1984	§149, Title 14, CCR	The Commission adds Section 149, Title 14, CCR, to prohibit any vessel, using or possessing a roundhaul net in Districts 16 and 17, from taking market squid between noon Friday and midnight Sunday and between noon and midnight on any Monday through Thursday.
1987	AB 123 (Farr)	Allows the use of lights to attract squid in District 17.
1988	AB 4055 (Farr)	Allows the use of lights to attract squid in District 16.
1989	SB 1080 (Mello)	Allows the use of all roundhaul nets, including purse seine and half-purse seine nets, to take squid in all portions (including the southernmost portion) of District 16, subject to the same area and season restrictions previously in effect for lampara nets.
1993	AB 14 (Hauser)	Restricts the use of attracting lights in District 10.
1993	SB 1030 (Thompson)	A landing tax of $0.0019/lb is imposed.
1997	SB 364 (Sher)	Authorizes the take of market squid north of Pt. Conception between noon on Sunday and noon on Friday. Requires a permit for the take of squid with a dip, purse seine, or lampara net for commercial purposes. Requires a permit to attract squid by light from a vessel. Establishes a fee for a commercial squid light boat owner's permit. Allows for transfer of vessel or light boat owner's permits under certain conditions. A three-year moratorium on commercial squid vessel permits is established; the possession of a permit from the previous year is required in order to renew.
1998	AB 1928 (Morrow)	No permit is necessary, nor is a landing tax imposed, for the take of live bait. Drum seines and other round haul nets excepted from prohibition of rings along lead line and pursing of net bottoms.
1998	AB 1241 (Keeley)	Marine Life Management Act passes.
2000	§149, Title 14, CCR	Amendment - Prohibits commercial take of market squid between noon on Friday and noon on Sunday from Pt. Conception south to the US-Mexico border. Requires commercial squid vessels and light boats to maintain logbooks detailing fishing/lighting activities.
2000	§149, Title 14, CCR	Amendment - Vessels fishing or lighting for squid are restricted to using no more than 30,000 watts of light. Each vessel fishing or lighting for squid must shield the entire filament of each light, directing the light downward, or the vessel must keep the illumination completely submerged underwater.
2000	SB 1544 (Sher)	Establishes a $400 fee for a commercial market squid vessel permit. Extends the sunset date for SB364 to 1 January 2004. Extends existing duties imposed on the Department and the Commission and makes an appropriation.

Table 4.1 Summary of Market Squid Regulations from 1959 to the present.

Date	Bill # (Author)	Regulation(s)
2001	SB 209 (Sher)	Requires the Commission to adopt the MSFMP by 31 Dec 2002, after consideration and public hearings. Requires the commission to establish fees for commercial market squid vessel permits and commercial squid light boat owner's permits annually commencing April 1, 2003. Prohibits each person who is issued a commercial squid light boat owner's permit from selling, trading, or transferring the permit to another person. Provides that specified provisions will become inoperative upon the adoption by the commission of a market squid fishery management plan and the adoption of implementing regulations and will be repealed 6 months thereafter.
2001	§149, Title 14, CCR	Proposed regulatory changes establish catch limits in order to protect the squid resource and manage the fishery sustainably. Established a harvest guideline of 125,000 short tons.

4.2 Estimation of MSY and/or OY

The provisions of the Magnuson-Stevens Act and National Standard Guidelines in 50CFR600 require that conservation and management measures prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery. Optimum yield (OY) is based on maximum sustainable yield (MSY), or on MSY as it may be reduced according to social, economic, or ecological factors. The most important limitation on the specifications of OY is that its selection, along with the conservation and management measures proposed to achieve it, must prevent overfishing. Each fishery management plan implemented by the Pacific Fisheries Management Council should include an estimate of MSY for any species included in the plan. Amendment Nine to the Coastal Pelagic Species Fisheries Management Plan (CPSFMP) was developed, in part, to provide a suitable MSY or MSY proxy for market squid.

4.2.1 Disapproved MSY Proxy Alternatives

In March of 2000, the Council's Scientific and Statistical Committee (SSC) noted that setting an MSY for market squid was impractical due to the following factors:

- Fishery and biological data are not sufficient.
- Markets tend to influence fishing effort, thus landings data are not reliable indicators of stock abundance.
- The short life span of squid combined with its vulnerability to oceanographic
  variation limits the practicality of the sustainable yield concept.

The CPS Management Team provided several alternatives for determining an MSY proxy value from landings information (3.2.4.1.1 to 3.2.4.1.3) that were rejected by the Pacific Fisheries Management Council.

4.2.1.1 MSY Based on Historical Landings

Due to the lack of data adequate to make a mathematical MSY determination, guidance was taken from the NMFS (National Marine Fisheries Service) publication: Technical Guidelines on the Use of Precautionary Approaches to Implementing National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act (Restrepo et al. 1998). Those guidelines propose that in data-poor situations such as the California market squid fishery, a proxy may be used for MSY, and that it is reasonable to use recent average catch from a period when there is no qualitative or quantitative evidence of declining abundance. Options for time periods warranting consideration are discussed in section 6.1.2.1.

Historic market squid data show that low landing periods correspond with El Niño events when availability of squid to the fishery are greatly reduced. The market squid fishery is volatile and reliant on the international market and availability of squid from other fisheries. In the time period between the last two El Niño events (1993-94 and 1997-98), there was a nearly unlimited demand for California market squid in the Republic of China, a situation that kindled rapid development of fishing and expansion of processing for export. The expansion ended with the onset of the1997-98 El Niño event during which market squid abundance and availability dropped to very low levels and landings declined.

The first fishing season (1999-00) following the two-year El Niño event resulted in the highest squid landings on record. Nearly all of the landings were from the southern California fishery (99.7%); landings reported from the northern fishery were minimal (0.3%). This disparity could not have been predicted given the current understanding of market squid abundance and distribution nor by utilizing temperature inclusive models.

The ability of the California market squid fishery to support landings of 124,263 short tons in 1996-97, followed by a strong El Niño and then repeat landings of the same magnitude in 1999-2000, suggests that the stock is robust enough to withstand these levels of landings.

The guidelines provided in Restrepo et al. (1998) were not generated for short-lived species. Current research indicates that squid live a less than one year, and the average age of squid taken in the commercial fishery are just over six months of age. As no effort data are available (clearly there were changes in effort due to expansion of the fishery and El Niño conditions), landings information alone does not provide data necessary to calculate an MSY proxy.

4.2.1.2 MSY Based on Expanding California Catch Data

Analysis of the CDFG landings database can provide general information on where squid are harvested. The location of commercial catches is recorded by fishing block (10 by 10 nautical miles). During the time period of 1981-2001

(Table 4-2), 262 unique blocks were recorded on landing receipts submitted for the sale of market squid. This number may be used to represent the total available or potential fishing area in the range of market squid for any given season. During the expansion of the fishery, the number of blocks fished has generally increased. If it is assumed that market squid have an equal chance of being caught in any of these blocks, the actual catch can be predicted by the ratio of exploited to unexploited blocks to calculate a *maximum catch potential* by season. Seasonal maximums are then averaged to obtain an MSY proxy.

A criticism of this option is that using a simple sum of all the blocks where catch has been reported is not an accurate method of calculating spawning area. There are vast differences in the productivity of the 262 blocks, and giving each one an equal weighting on an area basis would be erroneous. Although the northern Channel Islands are clearly the most productive areas in terms of catch, this may be an effect of increased effort or one driven by market conditions. For example, there are reports that abundance of squid at San Nicholas Island is often very high (from participants in squid and crab fisheries), yet reported squid catch is low. The quality of squid delivered to processors is an important issue, and fishing areas are often limited based on proximity to processing facilities. San Nicholas Island is approximately 70 miles offshore and is generally considered too far from port to catch and deliver a good quality product to the processor. Weather is also a limiting factor for fishermen when fishing further offshore.

Table 4-2. MSY based on expanding California catch data.

Season	Landings (short tons)	Blocks utilized	% Fishing Area (based on 262 blocks)	MSY Proxy
1981-1982	25,851	52	0.18	142,181
1982-1983	13,213	43	0.15	87,882
1983-1984	1,087	27	0.09	11,514
1984-1985	1,354	33	0.12	11,735
1985-1986	14,376	41	0.14	100,281
1986-1987	25,603	40	0.14	183,061
1987-1988	25,214	36	0.13	200,311
1988-1989	48,195	31	0.11	444,638
1989-1990	33,051	30	0.10	315,086
1990-1991	32,472	38	0.13	244,395
1991-1992	38,666	56	0.20	197,473
1992-1993	18,793	45	0.16	119,440
1993-1994	54,449	67	0.23	232,424

1994-1995	63,554	113	0.40	160,853
1995-1996	93,795	105	0.37	255,480
1996-1997	124,263	105	0.37	338,469
1997-1998	10,891	47	0.16	66,273
1998-1999	10,191	61	0.21	47,781
1999-2000	126,772	116	0.41	312,559
2000-2001	123,400	116	0.41	304,245

4.2.1.3 MSY Based on Coastwide Expansion from Midwater Trawl Data

Midwater trawl data are the only comprehensive source of coastwide information on squid distribution. Using this information assumes that these surveys can provide a measure of coastwide spawning area. Length information from these databases indicates a size range of 20 to 120 millimeters, which correlates to an age distribution of juveniles (9 weeks) to adult (Butler, et al. 2001). It is further assumed that there is little or no migration from spawning location to midwater trawl capture location.

MSY values calculated for the California fishery (Table 4-2) could be expanded to reflect additional unfished areas based on market squid observed in trawl data. Using information on squid density and proportion positive (Table 4-3) in the Pacific Northwest, California, and Mexico (assuming all tows were equal and not accounting for the year effects), the proportion of squid observed in California to the coastwide total equals approximately 71 percent. Scaling the above MSY proxy values for California upward accordingly, coast-wide MSY proxy values are estimated in Table 4-3.

Table 4-3. MSY based on coastwide expansion of midwater trawl data.

Location	Tows	Positive tows	Total squid caught	Squid per positive tow*	Proportion positive**	Ratio***	Portion in range
Pacific Northwest	419	111	4955	44.64	0.265	11.826	0.19
California	6009	1553	270837	174.40	0.258	45.072	0.71
Mexico	1410	152	8697	57.22	0.108	6.186	0.10
Total	7838	1816	284489			63.066	

* Squid per positive tow = total squid caught/positive tows.
** Proportion positive = positive tows/total tows.
*** Ratio = squid per positive tow × proportion positive.

Additionally, comparison of high-density squid catch areas with high-density squid trawl areas (ignoring differences between the sources of midwater and bottom trawl survey data), shows that catch may not be the best indicator of

abundance, as most of the high-density trawls occurred in the areas outside San Francisco, Monterey, Cape Mendocino, and southern Oregon, which are generally low density areas for catch. If there were a high correlation between the catch and tow data, an MSY proxy value based on this relationship would warrant consideration.

A criticism of this option is that the sources of survey data are different, therefore, lumping them together for treatment is erroneous. Several treatments of these data may be employed to improve the information, such as volume of water passing through the nets (not available at this time), or differences between the gear used. Seasonal and year effects were not considered in analysis of the trawl survey information, and were aggregated for the period of 1966 through 2000.

4.2.2 The Preferred Option: MSY Based on Egg Escapement

A proxy MSY will be used to estimate the amount of reproductive potential (fecundity) available for future populations. The fishery for market squid occurs only on their spawning grounds; these squid die after completing all spawning (all bouts of egg depositions), hence it is possible to calculate the fraction of the reproductive potential that escapes the fishery. The most precise method to estimate escapement would be to calculate the eggs the fishery removed by counting the number of eggs in the oviduct and ovary of females sampled from the catch and then subtracting this number from the number of eggs available before spawning. Since it would take at least four hours to count a single female's eggs, it would be impossible to directly estimate values in a timely fashion. Therefore, models were developed to indirectly estimate both the reproductive potential before spawning and that removed by the fishery (Macewicz et al. 2001). Reproductive potential before spawning is estimated by a simple linear equation based on dorsal mantle length while removal by the fishery is estimated by an exponential model based on gonad (ovary plus oviduct) weight and mantle condition. Using these models, Macewicz et al. (2001) indicated that during the period of December 1998 to December 1999, 34% of the reproductive potential of the catch escaped capture. They also recommend conducting direct measurements if there are major shifts in length composition of the commercial catch or significant fluctuations in environmental conditions (El Nino). The method is the preferred option of the CPS Management Team, SSC, and the CPS Advisory Subpanel.

The egg escapement method (EE) can be used to evaluate the effects of fishing mortality on the spawning potential of the squid stock. It is important to note that the egg escapement method does not provide estimates of historical or current total biomass such that a definitive yield (i.e., quota or Acceptable Biological Catch) cannot be determined at this time. The egg escapement method can be used to assess whether the fleet is fishing above or below a predetermined

sustainable level of exploitation and, thus, can be used as an effective management tool.

4.2.3 Overfished Condition Based on Egg Escapement

Because no biomass estimate exists for market squid, it is not possible to define an overfished condition for this species. Instead, if the 30% threshold for spawning stock is not realized for two consecutive years, an overfished condition may exist. Harvesting squid that have not spawned a minimum of 30% of their reproductive potential may negatively affect the sustainability of the fishery.

4.2.4 Allowable Biological Catch Alternatives Considered

The purpose of setting an Allowable Biological Catch (ABC) in this case would be to establish a point where action can be taken to prevent exceeding MSY. Regardless of where this point is, the action or actions taken would be developed through the points of concern mechanism contained in the CPS FMP. The following options were considered:

I. Status quo. Do not change the default ABC.
II. Set ABC equal to MSY.
III. Set ABC at 75 percent of MSY.

The CPS FMP defines the default ABC for monitored species as 25 percent of MSY and defines overfishing as exceeding ABC during any two consecutive years. When the CPS FMP was written, this was not foreseen as a potential problem with market squid because management was delegated to the state of California, although 25 percent of MSY is a reasonable ABC value for other small pelagic species (i.e., jack mackerel or anchovy). The proxy MSY is based on landings as supported by spawning area. There is no accurate estimate of MSY.

4.2.5 Allocation Issues

The Commission approved a 125,000 short ton harvest guideline in October 2001. If further research proves that the northern fishery and southern fishery are two different populations of squid, an allocation of the harvest guideline between the north and south should be considered. In recent years, the southern fishery has made 90 percent or greater of squid landings (see Table 3-1).

There is no consideration of allocation between the commercial and recreational catch since the recreational catch of squid is presumed negligible.

4.2.6 CPS FMP

Amendment 8

Optimum yield (OY) for squid was disapproved by the PFMC because the amendment did not provide an estimate of maximum sustainable yield (MSY), the theoretical concept on which OY and overfishing are based under the Magnuson-Stevens Act. The bycatch provisions were disapproved because Amendment 8 did not contain a standardized reporting methodology to assess the amount and type of bycatch in the fishery and because there is no explanation of whether additional management measures to minimize bycatch and the mortality of unavoidable bycatch are practicable at this time. The Council has directed its CPS management team (Management Team) and its CPS Advisory Subpanel to resolve these two issues. All other elements of Amendment 8 were approved.

The requirements of the Magnuson-Stevens Act, as amended by the Sustainable Fisheries Act, such as defining OY, overfishing, levels at which managed stocks are considered overfished, EFH, and social and economic data on fishing communities were discussed in the preamble to the proposed rule and are not repeated here.

Species in the FMP

Amendment 8 and this final rule place Pacific mackerel (*Scomber japonicus*), Pacific sardine (*Sardinops sagax*), jack mackerel (*Trachurus symmetricus*), and market squid (*Loligo opalescens*) in a management unit with northern anchovy (*Engraulis mordax*). All CPS are harvested by a fleet of vessels using mainly roundhaul nets (e.g., purse seines). Managed species are divided into two categories: “Actively managed" and “monitored”. Actively managed species are subject to annual harvest limits based on current biomass estimates. There are no mandatory harvest limits for monitored species; however, other management measures, such as area closures, could apply to monitored species. Amendment 8 sets the allowable biological catch (ABC) levels for monitored species well below estimates of MSY to prevent the need for detailed resource assessments until the domestic fishery necessitates active management of these species. Initially, Pacific sardine and Pacific mackerel are designated as actively managed species, while jack mackerel, northern anchovy, and market squid are monitored species.

4.3 Other Conservation of Stocks

Limited Market Order

The majority of squid is frozen for export to China, Japan and Europe, where it is considered a delicacy. Smaller amounts are sold fresh or canned. Squid is also frozen for bait where it is supplied to domestic commercial and recreational anglers, and is an important source of live bait for the California recreational fishing industry. In addition to its commercial value, squid is a vital food source

for many species of marine animals including fish, birds, and marine mammals. The economic value of market squid is balanced with its value as forage in this fishery management plan.